# MITIGATING CONDENSATION WITHIN ENCLOSURES

## PREVENTING DAMAGE AND ENSURING OPTIMAL LIFE FOR ENCLOSED ELECTRICAL AND ELECTRONIC EQUIPMENT

Electrical and electronic equipment, as well as components, are typically housed in an electrical enclosure designed to provide protection from the external environment. However, even with a sealed enclosure the introduction of moisture and water can result from a variety of circumstances. Once inside the enclosure, this water can accumulate—from small droplets on the components themselves to large puddles in the base of the enclosure. To address this concern, users employ a variety of methods intended to eliminate condensation and remove moisture. Yet, even small amounts of remaining moisture and liquid can result in costly damage to components, shorten the expected life cycle and affect overall component performance. In order to better protect components from condensation, a new, all-encompassing solution is needed—one that is effective, inexpensive and can be used in almost any industry.

While some enclosures are specifically built to protect against washdown, high-pressure spray may penetrate around sealed components and gaskets in many enclosures.

### HISTORY

Condensation results when moist air is cooled or comes into contact with a cool surface that is at or below its saturation point, also called its dew point. At this temperature air can no longer hold all the moisture, and water vapor condenses into moisture droplets on available surfaces. When temperatures are below freezing, the water vapor condenses into frost.

Various problems result when condensation forms on sensitive electrical and electronic devices inside an enclosure. Corrosion is one of the inherent troubles of moisture because it causes increased electrical resistance, which in turn generates additional heat and contributes to decreased and inconsistent component performance. In addition, corrosion can lead to rusting of critical electrical components, increasing the risk of circuits shorting out, as well as dangerous occurrences of arcing and sparking. In order to ensure optimal life expectancy of components, companies should take several precautions to help prevent these harmful conditions.

### CHALLENGE

Although complete condensation prevention is ideal, the circumstances that lead to its incidence are difficult to avoid. Condensation can stem from numerous sources in many environments and applications. For example, in indoor washdown applications, it is possible for high-pressure spray with soap lubricants to penetrate around sealed components and gaskets. Plus, in cases where conduit or pipe fittings aren't sealed properly, condensation may form in the pipe or conduit and drain directly into the enclosure. Even with best practices—leaks happen.

In wet or humid applications and environments, moisture enters an enclosure when the enclosure's door is opened for service or maintenance purposes. Since internal components generate heat within the enclosure, the warmed air inside can hold even more moisture. When the enclosure surfaces cool to the dew point as a result of shutdown, lower evening temperatures or lower outside air temperatures caused by a cool rain and other circumstances, condensation forms. Large temperature variations between the inside and outside of the enclosure can also result in pressure differences that may create a vacuum and draw water through the fittings and/or component and gasket seals. The best way to combat these harmful occurrences is by using a device to rid both the enclosure and the housed components of condensation. Finding an effective yet affordable solution, however, has proved problematic.

## PREVIOUS SOLUTIONS—AND SHORTCOMINGS

Several methods have been employed to prevent harmful corrosion on enclosure walls and equipment. While some methods are low-cost and low-tech, others are extremely sophisticated and costly. Equipment operators may attempt to rid enclosures of moisture by simply wiping them down with towels. However, in addition to being inconvenient, this method is usually only partially effective. Operators often wipe standing water from the bottom of an enclosure but not from the sensitive components themselves.

When water pooling in the enclosure bottom occurs, some users drill a small hole in the bottom of the enclosure and mount the enclosure at a slant to direct water towards the opening. While this method can be an effective way to drain the enclosure, it doesn't address the issue of moisture on the components themselves, and it allows humid air and water to re-enter through the very holes that were created to rid the enclosure of water—creating a continuous cycle of condensation. Even more importantly, any holes in an enclosure not filled with an appropriately rated device, which is approved by applicable UL or CSA standards, negate the enclosure's NEMA Type ratings.

Other lower cost methods work on the principle of maintaining the internal temperature above the dew point temperature to prevent air within the enclosure from reaching its dew point. Examples include light bulbs and heaters, which can also employ thermostat or humidity controls for more sophisticated monitoring. Still, higher temperatures allow more moisture in the air inside the enclosure and may cause detrimental effects to heat sensitive components. Another partial solution involves utilizing fans to increase airflow, which makes it more difficult for condensation to form on surfaces. Yet even with this method, if the temperature reaches dew point, condensation will form in locations where air movement is minimal.

The use of hazardous location-style drains and breathers provide the functionalities of draining and pressure equalization, but these devices are simply certified for hazardous location requirements, which are not the same as UL 508A and CSA 22.3 enclosure standards. They typically will not pass a Type 4 water hose down test, designed to ensure that water will be kept out of an enclosure. Plus, these drains and breathers do not address the problem of condensation on components and related performance and corrosion issues.

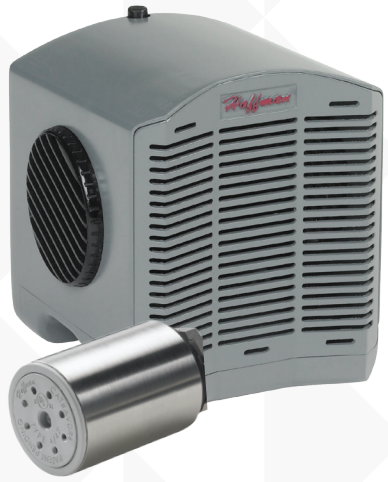
Air conditioners or Vortex coolers can be employed to maintain temperatures within a specified range, as well as remove moisture from the inside of the enclosure. Due to physical A/C sizes and filter maintenance requirements or the requirement of obtaining compressed air for a Vortex cooler, these solutions are often impractical and cost-prohibitive for many enclosure applications. In a situation where there is a lot of moisture in an enclosure and the A/C or Vortex cooler drops the temperature rapidly—possibly to the dew point or below before switching off—condensation of remaining moisture on the internal components and enclosure walls is possible. The same is true of heating and cooling device combinations used in applications with varying temperature ranges, such as those subject to a wide range of temperature extremes or seasonal climate changes.

## ENCLOSURE RATINGS

The National Electrical Manufacturers Association (NEMA), Underwriters Laboratories Inc. (UL) and Canadian Standards Association (CSA) are standard-writing organizations commonly recognized in North America. Their ratings are based on similar application descriptions and expected performance.

UL and CSA require enclosure testing by qualified evaluators. They also send site inspectors to ensure that manufacturers adhere to prescribed manufacturing methods and material specifications. NEMA does not require independent testing and leaves compliance entirely up to the manufacturer.

However, keep in mind that an enclosure rating can only be as high as the ratings of its enclosed components. This makes it critical to ensure both the enclosure and components are properly rated for the application requirements.



An electronic moisture removal device within the enclosure can be utilized to remove water vapor from the internal enclosure air, preventing condensation from forming on the enclosure walls and components.

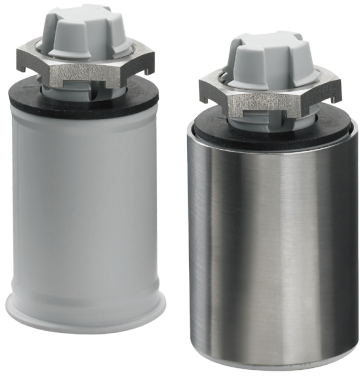
To rid enclosures of pooled water, a one-way drain is needed that is properly rated for the enclosure. The device should be designed to allow water to drain out, while preventing water and contaminants from reentering from the outside.

Finally, a purge system that uses pressurized dry air to maintain positive pressure on the inside of an enclosure prevents external moisture and dust from entering the enclosure, helps to reduce moisture within the enclosure itself and keeps components on the inside of the enclosure dry. The supply of dry air required by these units, however, can be expensive and difficult to acquire. Although this method helps prevent condensation, it is a costly solution and may not be a practical option for many applications—leaving a demand for a new, affordable and effective condensation solution.

## A SOLUTION THAT WORKS

A comprehensive solution is needed to ensure that water will be removed from the enclosure, while still maintaining the enclosure's integrity and environmental Type rating. A drainage device that equalizes pressure and allows accumulated water to drain out, while preventing water and contaminants from re-entering and maintaining UL and CSA enclosure certification, delivers this solution.

With the certified drain, humid air can still enter the enclosure when the door is open. However, when used in combination with an internal moisture-removing device, a total system solution is achieved—one that provides a continuous method of protection for the components and enclosure. This system solution removes internal enclosure moisture, controls condensation, reduces corrosion, drains pooled liquid and helps maintain optimal internal component expected life and performance.



The versatile H2OMIT Vent Drain is available in corrosion-resistant non-metallic material or encased in 304 stainless steel.

## A COMPREHENSIVE SOLUTION FROM HOFFMAN: H2OMIT™ CONDENSATION SOLUTION SYSTEM

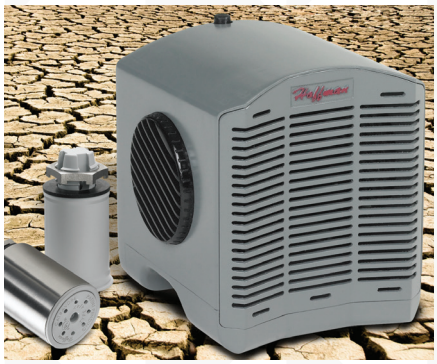
Hoffman's H2OMIT™ Condensation Solution System utilizes two components to assure reliable performance and realize the capabilities previously described. The vent drain device functions to equalize pressure and reduce the harmful effects of a temperatureinduced vacuum—that could pull water and moisture into the enclosure—in addition to providing a one way drain. As condensation accumulates and pools, it exits the enclosure and vent drain by the force of gravity. From the outside, water and contaminants are blocked from entry with a mechanical shut-off.

By incorporating Hoffman's thermoelectric dehumidifier, water vapor can be removed (pulled out) of the internal enclosure air. This process affords users a way to continuously remove and dry internal enclosure air, and in doing so, control condensation on components and enclosure walls. This moisture is then collected and directed to the vent drain device for expulsion from the enclosure.

The vent drain, which is approximately 2-inches long and 1¼-inches in diameter, is available in corrosion-resistant non-metallic polyester material or encased in 304 stainless steel. Non-metallic vent drains provide a cost-effective and corrosion-resistant certified solution for removing liquids that can be used on mild steel, aluminum, non-metallic and even some stainless steel enclosures. For stainless steel applications, including outdoor, food, beverage, water and petroleum, the 304 stainless steel vent drain provides the aesthetics and performance that these applications require.

For retrofit applications of enclosures already installed, the UL- and CSA-certified 508 Type 4/4X vent drain is easily installed by drilling a hole in the enclosure bottom or screwing directly into a ½-inch conduit hub. The thermoelectric dehumidifier can be installed on an interior back or side panel if space is available. Otherwise, this device is designed so that it can be installed on the enclosure bottom, directly above a vent drain, so it doesn't require panel space.

The thermolelectric dehumidifier combined with the UL- and CSA-rated vent drain provide a comprehensive protection solution, effectively and cost-efficiently combating damage to electrical and electronic parts due to condensation and ensuring maximum life expectancy and performance of internal components.



The H2OMIT Thermolelectric Dehumidifier and Vent Drain work to remove water vapor from the air and rid it from the enclosure for a comprehensive moisture removal and elimination solution.

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